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The effect of animation enhanced worksheets prepared based on 5E model for the grade 9 students on alternative conceptions of physical and chemical changes

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Abstract

The aim of this study is to determine the effect of teaching material based on 5E model for overcoming the alternative conceptions related to physical and chemical change. A quasi-experimental design and one control group (CG, N = 40) and one experimental group (EG, N = 40) were used. While the control group taught traditional instruction the experimental group received animation enhanced worksheets-based instruction. Teaching material included worksheet enriched with animations related to physical and chemical changes. The *Concept Achievement Test* consisting of 17 open-ended questions was used to collect data as pretest and posttest. Results indicate that while there is no statistically significant difference between groups in pretest, performance of EG students is greater than the CG ones in posttest. And also, the EG students are better in remediating their alternative conceptions related to the physical and chemical change. Based on the study, it is concluded that animation enhanced worksheets may be effective way to improve students' understanding of basic concepts and to dispell students' alternative conceptions.

Keywords: 5E Model, animations, worksheets, alternative conception, physical and chemical change

1. Introduction

In recent years constructivist theory of learning widely used in science education and presents the idea of environmental interaction with one's own knowledge in his mind that he is advocating the need (Brooks and Brooks 1999). Although 3E, 4E, 5E and 7E models have been put forward to facilitate the application of this theory, 5E model is the most used one among them (Hanuscin and Lee 2007). This model consists of activities which increase the student's research interest, subject to satisfying the expectations related to knowledge and skills and activities forcing the active use of data. 5E model at every stage encourages students to get involved in activities while at the same time it allows students to create their own concepts.

Computer animations (CA) have been used in science education to promote meaningful learning and to enhance conceptual change (Kelly and Jones, 2007). Several researchers have argued that CA are useful tools to show particulate interactions, which are necessary to explain observed chemical phenomena (Bunce and Gabel, 2002), as well as to help students understand chemistry by increasing their ability to visualize particle-level processes taking

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place at the microscopic level (Yezierski and Birk, 2006). Some of these events are either too fast or too slow, they are difficult to detect directly in dangerous and expensive laboratory experiments, whereas computer animations make it easier for students to portray the events at the microscopic level (Özmen *et al.* 2009). In addition, the computer animation allows opportunities to make a connection between processes and symbolic concepts which is considered to be good and trustful (Cağıltay *et al*. 1995).

Using worksheets to improve students' conceptual understanding is another constructivist-based approach. These materials guide students on what or how to do practical activities. The usual approach is that students complete worksheets, and share and discuss the ways they developed their ideas. In doing so, students participate in more meaningful discussion, meaning they are actively engage in their learning- a key feature of constructivism (Cahyadi, 2004).

Physical and chemical changes are two of the fundamental concepts in chemistry. In the literature, there have been several studies related to these concepts (Driver *et al.,* 1994; Hesse and Anderson, 1992; Sökmen, Bayram and Yılmaz, 2000). These studies have generally focused on students' understanding and alternative conceptions. Studies trying to determine the effect of different instructional methods on students' alternative conceptions are seldom. In this study, we tried to make such an investigation. Based on this we thought to use animations and worksheets. Literature suggests that using a single teaching method may in fact result in new learning difficulties because students may become bored, reducing their motivation to learn Türk and Çalık (2008). Therefore, in the study, we tried to combine worksheets with animations and aimed to determine the effect of animation enhanced worksheets on students' understanding and alternative conceptions on physical and chemical changes.

2. Methodology

2.1. Research Design and Sample

A quasi-experimental design was used in this study. The study utilized ''a pre-test/post-test non-equivalent comparison group design" (Robson, 1998) and one comparison group (CG) and one experimental group (EG) were used in the study. In the study, each group was given both a pre-test and a post-test, measuring the dependent variable both before and after exposure to the independent variable. While the CG took traditional instruction, the EG received animation enhanced worksheet-based instruction. The subjects for the study comprised of a total of 80 grade 9 students. One class (N = 40) was assigned as the experimental group (EG) and the other (N = 40) was chosen as the comparison group (CG). Two volunteer chemistry teachers were participated in the study and they taught the groups. The academicals backgrounds of the teachers were similar to each other.

2.2. Instruments

2.2.1. The Concept Achievement Test (CAT)

The test (CAT) consists of seventeen open-ended questions prepared by the researchers. All of the questions are related to physical and chemical changes. Five academicians and five chemistry teachers examined the test for content validity. The reliability coefficient of the test on Cronbach's alpha formula was found to be 0.73. Students were given 45 minute to complete the test.

2.2.2. Animation Enhanced Worksheets

Two animation enhanced worksheets were developed by the researchers and one of them was related to physical changes while the other was related to the chemical change. The worksheets consisted of five sections. The first section consisted of questions, the second section consisted of animations related to the concepts, the third section consisted of class discussion and teacher explanations, the fourth section consisted of daily life situations, and the fifth section consisted of questions for evaluation.

2.3. Procedure

Both experimental and control groups consisted of thirty grade 9 students and these groups were randomly assigned. For the experimental group, animation enhanced worksheets prepared for 5E model on physical and chemical changes. CAT was implemented as pre-test before the instruction to both groups. In control group, traditional instruction was implemented. In experimental group, animation enhanced worksheet-based instruction was applied. In this process, more student-centered instruction was made. During the application of the worksheets, in the first section, some questions were asked to the students related to concepts. In the second section, animations related to concepts were showed to the students, asked them to make observations. In third section, class discussion was made, students alternative conception related to concepts were discussed and teacher made some required explanations to the students. In fourth section, students were asked to link their views to daily life situations and to give daily life examples related to physical and chemical changes. In last section, evaluation was made by the teacher. Both experimental and control group students were observed during the application. CAT was implemented as post-test two weeks after the instruction to both groups.

2.4. Data Analysis

The questions on the test were evaluated by dividing them into categories such as 'Sound Understanding, Partial Understanding, Partial Understanding with a Specific Alternative Conception, Specific Alternative Conception and No Understanding'. Content and scoring of the test items was given in Table 1. SPSS 13.0 package program was used for the statistical analysis. The independent t-test was used to compare the pre-test and post-test scores of the groups for each of the instruments.

Table 1. Data analysis categories and scoring

Category	Description	Point
Sound Understanding (SU)	Explanation of answer with the correct reason	4
Partial Understanding (PU)	Giving answer with the reason that is partially correct	3
Partial Understanding with a Specific Alternative Conception (PU-SAC)	Explanation giving the correct reason with reason of the alternative concept	2
Specific Alternative Conception (SAC)	Wrong answer but the explanation contains correct answer given academically	1
No Understanding (NU)	Repeats a part or full question, irrelevant or undoable responses, and no answer. Such as "I don't understand", "I don't know" or "I have no idea"	0

3. Results

The mean average of the experimental group students in pretest was calculated as $\overline{X}_{\text{experimental (pre-test)}}$ =28.28, and for control group students it was $\overline{X}_{\text{Control (pre-test)}}$ = 28.65. The mean average of the experimental group students in posttest was calculated as $\overline{X}_{\text{experimental (post-test)}}$ = 39.28 and it was $\overline{X}_{\text{Control (post-test)}}$ = 31.20 for the control group students. Table 2 shows the statistically analysis of the collected data for both groups.

Table 2. Statistical analysis

	Group	N	Mean	Std. Deviation	Std. Error Mean	t	p
Pre-test	Experimental	40	28.28	7.355	1.163	-.216	.119
	Control	40	28.65	8.160	1.290	-.216	
Post-test	Experimental	40	39.28	7.118	1.125	4.519	.035
	Control	40	31.20	8.777	1.388	4.519	

According to t-test results in Table 2, it can be seen that there is no significant difference between pretest scores of experimental group and control groups (t=-.216; p> 0.05). Besides, it can be determined that there is a statistically significant difference between posttest scores of the groups (t=4.519; p< 0.05).

In the study, it was determined that students had several alternative conception related to physical and chemical change. In here, we presented four of the alternative conceptions as examples. Their percentages were above the 30% in pretest in both groups. Table 3 listed the percentages of alternative conceptions in pretest and post test.

Table 3. Percentages of students' alternative conceptions in pre-test and post-test

Questions	Alternative conception	Experimental group			Control group		
		Pretest (%)	Posttest (%)	Change	Pretest (%)	Posttest (%)	Change
Solution of salt in water	The salt disappears by liquifying in water, it is a chemical change because of the fact that the salt doesn't dissolve in the water	65	32,5	*+ 32,5*	55	52,5	*+ 2,5*
Melting of sugar	Melting of sugar is a combustion, so it is a chemical change.	75	25	*+ 50*	55	50	*+ 5*
Acquiring butter milk from yoghurt	When the buttermilk is made from yoghurt, the structure of yoghurt changes, new substance is formed and this is a chemical change.	62,5	40	*+ 22,5*	70	60	*+ 10*
Blackening of silver ring	If a blackened silver ring is boiled in hot water, it goes back. Therefore, it is a physical change.	67,5	42,5	*+ 25*	57,5	50	*+ 7,5*

As seen from the Table 3, students' alternative conceptions decreased from pretest to posttest in both groups. But, experimental group students were successful than the control group ones in dispelling their alternative conceptions. This shows that animation enhanced worksheets may be effective materials in teaching of physical and chemical change concepts.

4. Discussion

It is well known that students do not learn science concepts as expected by the instructor. The abstract nature of science concepts, traditional teaching strategies, and teacher-centered applications are the main sources of the difficulty. Traditional teaching approaches focus on the macroscopic and symbolic level of chemistry (Kelly *et al.,* 2004) and generally do not consider students' alternative conceptions. Also, we know that such a traditional approach is not suitable for teaching the microscopic nature of matter such as the properties and motion of the particles that make it up. Recently, aware of students' difficulties and alternative conceptions, science and chemistry teachers have used different instructional methods for teaching of the chemistry concepts (Ngo, 2006; Özmen, 2011). In this study, we also tried to use the animations enhanced worksheets as an alternative instructional approach and to determine the effect of animation enhanced worksheets –based instruction on students' understanding and alternative conceptions related to physical and chemical change concepts and to compare the results with traditional instruction. While there was no significant different between the pretest results, it was determined a significant difference between the posttest results in favor of the experimental group. The results of the study show that experimental group students are successful than the control group ones. Similarly, different researchers have employed alternative teaching approaches or combinations to show the effectiveness of them on students' understanding or alternative conceptions. Worksheets and CA are frequently used in teaching of different chemistry concepts. Although worksheets are commonly used in teaching of chemistry concepts, students still cannot visualize the phenomena at microscopic or particulate level. Animations will help instructors to show the

microscopic nature of chemical events to the students. Based on the results, we may say that such a combination may be a useful way to teach chemistry concepts more effectively. On the other hand, we do not forget that none of the teaching approaches have a magic touch in constructing the expected understanding in students' minds.

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